

## PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION  
(PCT Rule 61.2)

Date of mailing (day/month/year) 09 January 2001 (09.01.01)	To:  Commissioner US Department of Commerce United States Patent and Trademark Office, PCT 2011 South Clark Place Room CP2/5C24 Arlington, VA 22202 ETATS-UNIS D'AMERIQUE  in its capacity as elected Office
International application No. PCT/EP00/04652	Applicant's or agent's file reference 99.0123/001
International filing date (day/month/year) 22 May 2000 (22.05.00)	Priority date (day/month/year) 20 May 1999 (20.05.99)
<b>Applicant</b> BARNARDO, Christopher, John, Andrew et al	

1. The designated Office is hereby notified of its election made:

in the demand filed with the International Preliminary Examining Authority on:

04 December 2000 (04.12.00)

in a notice effecting later election filed with the International Bureau on:

\_\_\_\_\_

2. The election  was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No.: (41-22) 740.14.35	Authorized officer  Juan Cruz  Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>99.70123/001</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/EP 00/04652</b>	International filing date (day/month/year) <b>22/05/2000</b>	(Earliest) Priority Date (day/month/year) <b>20/05/1999</b>
Applicant <b>CAMBRIDGE CONSULTANTS LIMITED</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

- the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing :
- contained in the international application in written form.
- filed together with the international application in computer readable form.
- furnished subsequently to this Authority in written form.
- furnished subsequently to this Authority in computer readable form.
- the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2.  Certain claims were found unsearchable (See Box I).

3.  Unity of Invention is lacking (see Box II).

4. With regard to the title,

- the text is approved as submitted by the applicant.
- the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- the text is approved as submitted by the applicant.
- the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

- as suggested by the applicant.
- because the applicant failed to suggest a figure.
- because this figure better characterizes the invention.

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- None of the figures.

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 00/04652

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H05B33/26 H05B33/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 757 128 A (TOPP MARK) 26 May 1998 (1998-05-26) the whole document ----	1-14, 17-20
A	US 5 504 390 A (TOPP MARK) 2 April 1996 (1996-04-02) the whole document ----	1-14, 17-20
A	US 5 821 691 A (RICHIE BENJAMIN L ET AL) 13 October 1998 (1998-10-13) the whole document -----	1-14, 17-20

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

## ° Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

5 September 2000

Date of mailing of the international search report

12/09/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Drouot-Onillon, M-C

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International Application No  
PCT/EP 00/04652

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 5757128 A	26-05-1998	US	5504390 A	02-04-1996
US 5504390 A	02-04-1996	US	5757128 A	26-05-1998
US 5821691 A	13-10-1998	NONE		

## PATENT COOPERATION TREATY

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 99.70123/001	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP00/04652	International filing date (day/month/year) 22/05/2000	Priority date (day/month/year) 20/05/1999
International Patent Classification (IPC) or national classification and IPC H05B33/26		
Applicant CAMBRIDGE CONSULTANTS LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I     Basis of the report
- II     Priority
- III     Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV     Lack of unity of invention
- V     Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI     Certain documents cited
- VII     Certain defects in the international application
- VIII     Certain observations on the international application

Date of submission of the demand 04/12/2000	Date of completion of this report 20.08.2001
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  Mayne, J Telephone No. +49 89 2399 8572



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/EP00/04652

**I. Basis of the report**

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, pages:**

1-13                   as originally filed

**Claims, No.:**

1-20                   as originally filed

**Drawings, sheets:**

1/3-3/3               as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- the language of publication of the international application (under Rule 48.3(b)).
- the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- contained in the international application in written form.
- filed together with the international application in computer readable form.
- furnished subsequently to this Authority in written form.
- furnished subsequently to this Authority in computer readable form.
- The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- the description,               pages:
- the claims,                   Nos.:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP00/04652

- the drawings, sheets:
5.  This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):  
*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*
6. Additional observations, if necessary:

## IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:
- restricted the claims.
- paid additional fees.
- paid additional fees under protest.
- neither restricted nor paid additional fees.
2.  This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is
- complied with.
- not complied with for the following reasons:  
**see separate sheet**
4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:
- all parts.
- the parts relating to claims Nos. 1-14, 16.

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N) Yes: Claims 1-14, 16  
No: Claims

Inventive step (IS) Yes: Claims 1-14, 16  
No: Claims

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/EP00/04652

Industrial applicability (IA) Yes: Claims 1-14, 16  
No: Claims

**2. Citations and explanations  
see separate sheet**

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/EP00/04652

**Re Item IV**

**Lack of unity of invention**

With the communication of 26.1.01 this authority established a lack of unity of invention, i.e. Rule 13.1 PCT is not complied with, as follows:

Reference was made to the following documents:      D1: US-5,821,691  
    D2: US-5,757,128  
    D3: US-5,504,390

**Group A**

Claim 1 and its dependent claims concern an addressable electroluminescent display comprising layers 1-6 as therein defined.

Dependent claim 16 concerns an item of clothing comprising an addressable electroluminescent display with a plurality of display areas as defined in independent claim 15. Claim 16 refers to the addressable electroluminescent display of claim 1-13.

**Group B**

Independent claim 15 concerns an item of clothing comprising an addressable electroluminescent display with a plurality of display areas as therein defined. Claim 15 makes no reference to the addressable electroluminescent display of claim 1.

**Group C**

Claim 17 concerns an electroluminescent display comprising 6 items as therein defined.

Independent claim 20 concerns an item of clothing comprising an electroluminescent display which comprises an electroluminescent device according to claims 17-19.

The common concept between Groups A and B is an addressable electroluminescent display. This concept is known from the prior art D1-D3.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP00/04652

The common concept between Groups A and C is an addressable electroluminescent display with the following:

- 1 first electrode
- 2 second electrode
- 3 layer of electroluminescent material between first and second electrodes
- 4 electrical conductive track connected to the second electrode

This concept is known from the prior art D2 (Figs. 2 and 7).

Claims 1 and 17 diverge in the following respects:

- 5 there is no requirement for the electrical conductor of claim 17 to be in the form of a layer with a plurality of electrically conductive tracks as in claim 1.
- 6 the electrically conductive backplane of claim 1, 6th layer, is located between the 3rd and 5th layers, i.e. between the electroluminescent material and the dielectric material which follows the path of the electrically conductive track.  
In contrast the electrically conductive layer of claim 17 is located between the electroluminescent material and the electrically conductive track.
- 7 claim 1 has a layer of dielectric material, 5th layer, located between the 4th and 6th layers, i.e. between the plurality of electrically conductive tracks and the electrically conductive backplane.  
In contrast the dielectric layer of claim 17 is located between the electrically conductive track and the conductive layer.

This authority therefore found that there are 3 "inventions" in the application. The Applicant was invited to restrict the claims or to pay the additional examination fees.

The Applicant was informed that in the absence of a reply the written opinion would be drawn up for the claims in Group A, i.e. claims 1-14 and 16.

The Applicant responded with a letter dated 22.2.01 asking for the written opinion to be based on claims 1-14 and 16.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP00/04652

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**Article 33(2) PCT**

US-5,821,691 (D1) is considered to be the closest prior art since it discloses an addressable electroluminescent display described as follows with reference to Fig 4:

A transparent film 51 is coated forming a 1st electrode (52).

This is followed by a phosphor layer (55).

This is followed by an insulating layer (56).

This is followed by a plurality of rear electrode segments (57, 58).

This is followed by an insulating layer (61).

This is followed by a conductive layer (63).

Wiring to the rear electrode (57) and the conductive layer (63) is provided by bus bars (65, 67).

Bus bar (67) can be coupled with the front electrode (col. 4, l. 55 ff.) thereby bringing the conductive backplate and front electrode to the same potential.

However, D1 makes no mention of the 5th layer of claim 1, which is a dielectric layer insulating the electrically conductive tracks (4th layer) from the electrically-conductive backplane (6th layer).

Claims 1-14 and 16 are therefore novel and fulfill the requirements of Article 33(2) PCT.

**Article 33(3) PCT**

The 4th layer of claim 1 contributes to solving the problem of the electrical connections being visible as illuminated regions of the electroluminescent material (see description p. 3-4). This was not foreseeable from D1.

Claims 1-14 and 16 therefore fulfill the requirements of Article 33(3) PCT.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/EP00/04652

**Re Item VIII**

**Certain observations on the international application**

**Article 6 PCT**

The final feature of claim 1 "wherein, in use..." is a process feature which is not a limitation to the electroluminescent display *per se*.

All claims require full support in the description.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)



**(19) World Intellectual Property Organization  
International Bureau**



**(43) International Publication Date  
30 November 2000 (30.11.2000)**

PCT

**(10) International Publication Number  
WO 00/72638 A1**

**(51) International Patent Classification<sup>7</sup>:** H05B 33/26,  
33/06

**Christopher, John, Andrew** [GB/GB]; 42 Grange Road, Bishops Stortford, Hertfordshire CM23 5NQ (GB).  
**FRYER, Christopher, James, Newton** [GB/GB]; 149 High Street, Cottenham, Cambridgeshire CB4 8SD (GB).

**(21) International Application Number:** PCT/EP00/04652

**At:** DIXON, Philip, Matthew; Frank B. Dehn & Co.,  
Queen Victoria Street, London EC4V 4EL (GB).

(22) International Filing Date: 22 May 2000 (22.05.2000) (74) Agent: DIXON, Philip, Matthew; Frank B. Dehn & Co., 179 Queen Victoria Street, London EC4V 4EL (GB).

**(25) Filing Language:** English

(81) Designated States (*national*): GB, US.

**(26) Publication Language:** English

**(84) Designated States (regional):** European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

**(30) Priority Data:** 9911789.7 20 May 1999 (20.05.1999) GB

(71) Applicant (for all designated States except US): CAMBRIDGE CONSULTANTS LIMITED [GB/GB]; Science Park, Milton Road, Cambridge CB4 4DW (GB).

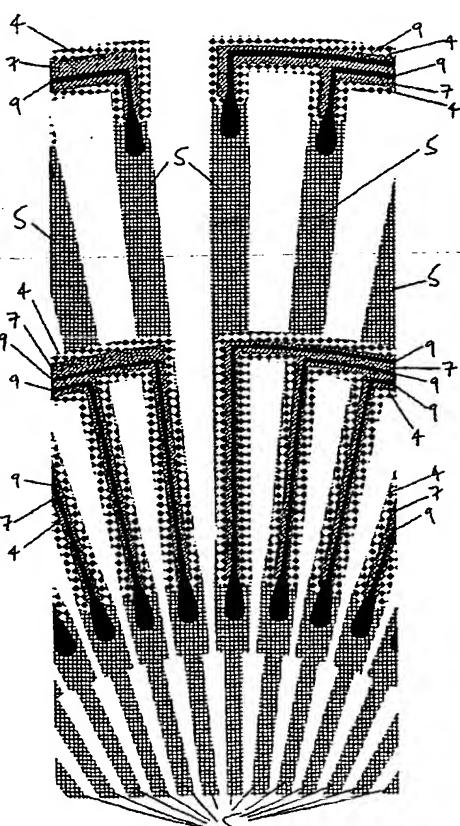
**Published:**

— *With international search report.*

(72) Inventors; and  
(75) Inventors/Applicants (*for US only*): BARNARDO,

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: ELECTROLUMINESCENT DISPLAY



**(57) Abstract:** An electroluminescent display comprises a transparent front-electrode (1, 2), rear electrodes (5), and a layer of electroluminescent material (3) located between the first and second electrodes. Conductive tracks (9) are electrically connected to the rear electrodes (5) and supply a driving voltage for the electroluminescent material (3) to the rear electrodes (5). A backplane layer (7) is provided between the electroluminescent material layer (3) and the conductive tracks (9), and is electrically connected to the front electrode (1, 2), such that the potential difference across the electroluminescent material layer (3) in the region of the conductive tracks (9) is substantially zero. In this way, when the conductive track (9) is supplying the driving voltage to the rear-electrodes (5), the electroluminescent material layer (3) is not illuminated by an electric field between the conductive tracks (9) and the front electrode (1, 2). Gaps may be defined in the front electrode (1, 2) corresponding substantially to the location of the conductive tracks (9). This also prevents the voltage in the conductive tracks (9) from illuminating the electroluminescent material layer (3). An addressable electroluminescent display may be included in an item of clothing.

WO 00/72638 A1

Electroluminescent Display

5       The present invention relates to electroluminescent displays.

10      Electroluminescence is the emission of light by a material when subjected to an electric field. Phosphor electroluminescence was discovered and documented in 1936. However, it was only in the 1950's that GEC and Sylvania received patents for electroluminescent powder lamps. The short lifetime, for example 500 hours, of such devices limited their usefulness.

15      Work carried out in the 1980's revitalised the powder electroluminescent lamp, and in 1990 the Durel Corporation demonstrated a flexible electroluminescent phosphor device that was incorporated as a backlight into a liquid crystal flat panel display. The manufacturing technique involved encapsulating the phosphor powder particles in glass beads and sandwiching the encapsulated powder between two electrodes, to which an AC voltage was applied to stimulate emission.

20      Electroluminescent devices made according to this type of method are known as "thick film" or "powder" electroluminescent devices. This is to be contrasted with "thin film" electroluminescent devices, in the manufacture of which a thin layer of electroluminescent phosphor is deposited on a, typically glass, substrate by a method such as atomic layer epitaxy.

25      Traditionally, thin film technology has been used to make electroluminescent displays, and thick film technology has been used to make electroluminescent lamps, in particular backlights for liquid crystal displays (LCDs). An example of a thin film device is described in US Patent 5,463,279, and an example of a thick film device is described in US Patent 5,686,792.

30      A typical thick film phosphor electroluminescent

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device comprises a layer of electroluminescent material in a dielectric matrix, sandwiched between two planar conducting electrodes. The electroluminescent material comprises phosphor particles, typically a zinc sulphide (ZnS) powder doped with manganese (Mn),  
5 microencapsulated in a dielectric material. Typically, silver- or graphite-loaded screen-printable inks, and indium tin oxide (ITO), a transparent conductive material, respectively are used to form the electrodes  
10 on a substrate such as a polyester film. When an AC voltage is applied between the electrodes, the electroluminescent material emits light.

The inventors have recently developed thick film electroluminescent displays in which a plurality of shaped independent electrodes are provided on at least one side of a layer of shaped or unshaped electroluminescent material. A voltage may be applied selectively to each of these independent electrodes to illuminate a respective region of the display. A thick film electroluminescent display is created by selecting the configuration of the independent electrodes to represent information, for example in the form of a seven-segment display or the like.

Thus, the inventors have recently developed an addressable electroluminescent display, i.e. an electroluminescent display comprising a plurality of display areas each having the shape of a graphical element wherein each display area may be separately, selectively illuminated.

A problem associated with the manufacture of thick film electroluminescent displays is that the independent electrodes must be connected electrically to a voltage source for the display. In a convenient manufacturing technique, electrical connections are applied as conductive tracks on the rear surface of the device, for example by screen printing conductive ink. However, the tracks themselves can act as electrodes and cause the

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electroluminescent phosphor to emit light where the phosphor is sandwiched between a transparent front electrode and the conductive track. Thus, the conductive tracks appear as illuminated lines on the display and adversely affect the clarity of the displayed information, which is undesirable.

US Patent 5,686,792 relates to an electroluminescent lamp with a continuous electroluminescent dielectric layer and a patterned rear electrode overlying the electroluminescent dielectric layer. The rear electrode includes at least two conductive segments separated by a gap. An insulating layer fills the gap and a conductive interconnect overlies the insulating layer, joining the segments. The insulating layer spaces the interconnect from the electroluminescent dielectric layer a sufficient distance to reduce the electric field in the electroluminescent dielectric layer below the point at which the lamp appears luminous.

The solution to the problem of visible electrical interconnections in the context of an electroluminescent lamp provided by US 5,686,792 has certain disadvantages. For example, the depth of the insulating layer is fixed by the manufacturing process and this depth determines a maximum voltage which can be applied to the rear electrode without causing illumination of the electrical connections in the electroluminescent display. Furthermore, the thickness of the insulating layer must be carefully controlled to ensure the invisibility of the interconnections, and this places additional constraints on the manufacturing process. Also the thickness and inflexibility of the insulating layer adds to the overall thickness of the display and detracts from its flexibility.

The present invention seeks to provide a novel configuration of an electroluminescent display in which the electrical connections to the electrodes of the

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display are not visible as illuminated regions of the electroluminescent material.

Viewed from a first aspect therefore the invention provides an addressable electroluminescent display comprising:

5 a first layer comprising an electrically-conductive, transparent, front-electrode;

a second layer comprising a plurality of electrically-conductive, rear-electrode segments;

10 a third layer located between the first and second layers and comprising electroluminescent material;

a fourth layer comprising a plurality of electrically-conductive tracks each of which is

15 electrically connected at a first end to at least one of the rear-electrode segments;

a fifth layer located between the fourth layer and a sixth layer (defined below), comprising dielectric material and following substantially the path of the 20 electrically-conductive tracks; and

a sixth layer located between the third and the fifth layers, comprising an electrically-conductive, backplane which:

25 is electrically connected to the front-electrode in front of the backplane such that the potential difference across the third layer in the region of the sixth layer is substantially zero;

follows substantially the path of the electrically-conducting tracks;

30 wherein, in use, a driving voltage for driving the illumination of an area of the display is supplied across the first layer and a rear electrode segment in the second layer.

Thus according to the invention, in the region of the electrically-conductive tracks (or "electrical conductor"), the electrically conductive backplane (or "sixth layer" or "electrically conductive layer")

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ensures that there is substantially no potential difference across the electroluminescent material layer (or "third layer"), even if the electrically-conductive tracks are supplying driving voltage, and the  
5 electrically-conductive tracks therefore do not cause the electroluminescent material to illuminate.

The first layer (or "first, transparent electrode") may comprise a layer of a transparent conductive material, for example indium tin oxide, applied to a  
10 transparent substrate, for example a polyester film. The transparent conductive material may be applied to the transparent substrate by any suitable method, for example screen printing, sputtering and the like.

15 The configuration of the display is such that information can be represented by the display by the application of a voltage to selected rear-electrode segments (or "second electrodes"). For example the areas that can illuminate ("display areas") may be arranged in a numeric or alphanumeric display  
20 arrangement, such as a seven, fourteen or sixteen segment display.

25 The rear-electrode segments may be provided on the display by any suitable method, such as by screen printing with conductive, for example silver- or graphite-loaded, inks.

30 The electroluminescent material in the third layer (or "layer of electroluminescent material") is a thick film phosphor layer, for example zinc sulphide powder doped with manganese and microencapsulated in a dielectric material.

35 The electrically-conductive tracks may be formed on the device by any suitable method, such as by screen printing with conductive, for example silver- or graphite-loaded, inks. Feasibly, some electrically-conductive tracks may be formed on the device together with the rear-electrode segments. In this case, these electrically-conductive tracks may be

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considered as an extension of the relevant rear-electrode segments. At least part of the electrically-conductive tracks may be integral with the rear-electrode segments.

5 In general, a respective electrically-conductive track is provided for each rear-electrode segment.

The sixth layer (or "electrically conductive layer") may be arranged in substantially the same plane as the second layer. Thus, for example, the 10 rear-electrode segments may be provided in one or more voids or recesses defined in the sixth layer. In this case, the spacing between the sixth layer and the rear-electrode segments, defined by the size of the voids, should be selected to prevent arcing due to 15 potential differences between the sixth layer and the second layer.

A layer of dielectric material (or "fifth layer" or "first dielectric layer") is provided to insulate electrically the electrically-conductive tracks from the 20 sixth layer, as there may be a significant potential difference between these components. Thus, such a dielectric layer must have sufficient electrical insulation capability to withstand the driving voltage for the electroluminescent material. This dielectric 25 layer may be applied by any suitable method, such as screen printing.

In a preferred arrangement, the sixth layer is provided over the second layer. This arrangement has the advantage that the registration of the sixth layer 30 relative to the second layer does not need to be as accurate to ensure correct electrical functioning of the device as when the rear-electrode segments are provided in voids or recesses in the sixth layer.

A further dielectric layer (or "second dielectric 35 layer") may be provided to electrically insulate the second layer from the sixth layer, which will generally be at different potentials in use of the device. Such a

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dielectric layer may be applied by any suitable method, for example screen printing.

It is advantageous for any voids which exist in the sixth layer and any dielectric layers (for the purpose of allowing the electrically-conductive tracks to connect to the rear-electrode segments) to be made as large as possible in order to minimise the effect of any mis-registration of the sixth layer (and/or the associated dielectric layer(s)), the rear-electrode segments and the electrically-conductive tracks.

The sixth layer follows substantially the path of the electrically-conductive tracks, in order to reduce the cost of materials and to reduce registration problems associated with other methods. It is desirable for the fifth layer to cover a greater area than the sixth layer, so that electrical insulation is generally assured even in the case of variations in the registration of these layers. Likewise, it is desirable for the sixth layer to cover a greater area than the electrically-conductive tracks, so that the electrically-conductive tracks are generally not visibly illuminated even in the case of variations in the registration of the sixth layer relative to the electrically-conductive tracks.

Preferably, the sixth layer and the associated dielectric layer(s) overlap the area of the rear-electrode segments in order to allow for tolerances in the registration of the sixth layer and the associated dielectric layer(s) relative to the electrically-conductive tracks.

Preferably, the overall area of the sixth layer and the associated dielectric layer(s) is maintained as small as possible to minimise the probability of a short circuit due to imperfections, such as pin holes, in the dielectric layer(s).

The sixth layer may comprise a plurality of separate portions, each electrically connected to the

relevant part of the first layer.

In advantageous embodiments, at least one of the rear-electrode segments of the electroluminescent device, or the sixth layer, or the electrically-conductive tracks may be formed as conductive tracks on a printed circuit board, preferably a flexible printed circuit board.

A void (or gap) may be provided in the first layer opposite an electrically-conductive track, so that an electric field is not generated between the first layer and the electrically-conductive track, which would cause the electroluminescent material to illuminate in the region of the electrically-conductive track.

The void(s) may be defined in the first layer by etching or otherwise ablating (e.g. using lasers) the transparent conductive material from the transparent substrate. Alternatively, the transparent conductive material may be applied to a transparent substrate in a configuration which defines the void(s).

According to the invention, electroluminescent devices may be made which are flexible, lightweight and relatively inexpensive. Advantageously, an electroluminescent display may be incorporated into an item of clothing.

Thus, viewed from a second aspect the invention provides an item of clothing comprising an addressable electroluminescent display with a plurality of display areas each having the shape of a graphical element and each of which may be separately, selectively illuminated.

The electroluminescent display may be arranged to display information relating to the wearer of the clothing. For example, the display may represent an amount of oxygen which remains in the tanks of breathing apparatus used by a fire-fighter or a diver. Similarly, the display could represent the elapsed time from the start of a race for a particular athlete.

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The electroluminescent display may include additional electronics for controlling the display. For example, the display may include short-range communication electronics for example utilising the DECT or Blue Tooth communications protocols.

Advantageously, the electroluminescent display may comprise an electroluminescent device according to the first aspect of the invention.

Although the invention has been described in terms of the structure of an electroluminescent display, the invention also extends to a method of making such a display as described herein.

Viewed from a yet further aspect, the invention provides an electroluminescent display comprising:

a first, transparent electrode;  
at least one second electrode;  
a layer of electroluminescent material located between the first and second electrodes;  
an electrical conductor in the form of a conductive track, electrically connected to the second electrode and arranged to supply, in use, a driving voltage for the electroluminescent material to the second electrode;

an electrically conductive layer which is provided between the electroluminescent material layer and the electrical conductor, substantially following the path of the electrical conductor, said conductive layer being electrically connected to the first electrode, such that the potential difference across the electroluminescent material layer in the region of the electrical conductor is substantially zero; and

a first dielectric layer located between the electrical conductor and the conductive layer.

Some embodiments of the invention will now be described by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of an electroluminescent display showing some aspects of the

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invention;

Figure 2 is an exploded view of the device of Figure 1;

5 Figure 3 is a schematic representation of an electroluminescent display showing some aspects of the invention.

As shown in Figure 1 an electroluminescent display according to the invention comprises a substrate layer 1 of transparent polyester, which is prefabricated with a 10 layer of indium tin oxide (ITO) 2 to form a transparent front-electrode. A layer of thick film electroluminescent phosphor material 3 is provided on top of the ITO layer 2. A first dielectric layer 4 is provided over the phosphor layer 3, and on top of the 15 first dielectric layer 4 is provided a rear-electrode 5 of screen-printed silver-loaded ink. The rear-electrode 5 is covered by a second dielectric layer 6. The second dielectric layer 6 electrically isolates the rear-electrode 5 from a backplane layer 7, also of 20 screen-printed silver-loaded ink. On top of the backplane layer 7 is provided a third dielectric layer 8, which electrically isolates the backplane layer 7 from an electrically-conductive track 9.

The electrically-conductive track 9 thus runs in a 25 longitudinal direction between a point at one end of the track where it is connected to a rear-electrode segment and a point at another end of the track where it is connected either directly or indirectly to a voltage supply. The direction of "width" (as used herein) of the electrically-conductive track and of other tracks 30 associated with the electrically-conductive track is defined as that direction which is substantially perpendicular to the longitudinal direction of the electrically-conductive track.

35 As shown in Figure 1, the backplane layer 7 is electrically connected to the ITO layer 2 so that these two layers are always at the same electrical potential.

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In use, an AC driving voltage of 100 to 600 volts is applied between a rear-electrode segment 5 (via the conductive track 9) and the ITO layer 2, in order to generate an electric field across the electroluminescent phosphor 3 so that the phosphor emits light.

The conductive backplane layer 7 is always at substantially the same electrical potential as the ITO layer 2, and is located between the phosphor layer 3 and the conductive track 9. There is therefore no electric field across the electroluminescent phosphor layer 3 due to the driving voltage in the conductive track 9. In effect, the backplane layer 7 shields the electroluminescent phosphor layer 3 from the driving voltage in the conductive track 9, so that the phosphor layer 3 is not illuminated by the conductive track 9.

Although the third dielectric layer 8, the backplane layer 7, and the second dielectric layer 6, are represented in Figure 2 as having voids defined therein for the conductive track 9, for a display according to the invention, the third dielectric layer 8, the backplane layer 7, and the second dielectric layer 6, in fact, follow substantially the path of the conductive track 9, in order to reduce the cost of materials and to prevent registration problems between these layers, as shown in Figure 3.

Figure 3 shows a plurality of rear electrodes 5 which are configured to form the hour, minute and second hands on the top part of an analogue clock display. Electrically-conductive tracks 9 are connected to these rear electrodes 5. The conductive tracks 9 sit on a second dielectric layer (not shown in Figure 3) which in turn sits on a backplane layer 7 which in turn sits on a first dielectric layer 4.

In summary, an electroluminescent display comprises a transparent front-electrode 1,2, a rear-electrode 5, and a layer of electroluminescent material 3 located between the front and rear electrodes. A conductive

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track 9 is electrically connected to the rear-electrode 5 and supplies a driving voltage for the electroluminescent material 3 to the second electrode 5. A backplane layer 7 is provided between the 5 electroluminescent material layer 3 and the conductive track 9, and is electrically connected to the front electrode 1,2, such that the potential difference across the electroluminescent material layer 3 in the region of the conductive track 9 is substantially zero. In this 10 way, when the conductive track 9 is supplying the driving voltage to the rear electrode 5, the electroluminescent material layer 3 is not illuminated by an electric field between the conductive track 9 and the front electrode 1,2.

15 Note that although the description has mainly described embodiments in which the shape of illuminated areas are defined by the rear electrodes, this shape may alternatively be defined by appropriate shaping of the front electrode or the electroluminescent material layer 20 or a combination of the front electrode, the electroluminescent material and the rear electrode.

It is also to be noted that, with suitable provision of driving voltages (that is, actively driving "on" displays areas to be illuminated and "off" display 25 areas to not be illuminated), there is no need for a backplane layer to be provided in areas behind rear-electrode segments, since those rear-electrode segments which are driven "off" (i.e. set to the same voltage as the transparent, front-electrode) act in the 30 same way that such a backplane layer would and ensure that electrically-conductive tracks which run behind them cannot cause any illumination of the electroluminescent material in front of them. It is further to be noted that there is also no need to 35 provide a backplane layer in areas of the display where there is either no front-electrode or no electroluminescent material or no

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electrically-conductive track.

In an alternative arrangement (not shown), a gap is defined in the front electrode 1,2 corresponding substantially to the location of the conductive track 9.

5 This also prevents the voltage in the conductive track 9 from illuminating the electroluminescent material layer 3.

An electroluminescent display may be included in an item of clothing.

10 It is possible to prevent the unwanted illumination of the electrical conductors without the use of a conductive layer as described above.

In this case, an electroluminescent device comprises:

15 a first, transparent electrode;  
at least one second electrode;  
a layer of electroluminescent material located between the first and second electrodes; and  
an electrical conductor electrically connected to  
20 the second electrode and arranged to supply, in use, a driving voltage for the electroluminescent material to the second electrode,

wherein a void is defined in the first electrode corresponding substantially to the location of the  
25 electrical conductor.

Thus a void (or gap) is provided in the first electrode opposite the electrical conductor, so that an electric field is not generated between the first electrode and the electrical conductor, which would cause the electroluminescent material to illuminate in  
30 the region of the electrical conductor.

Claims

1. An addressable electroluminescent display comprising:

- 5        a first layer comprising an electrically-conductive, transparent, front-electrode;
- a second layer comprising a plurality of electrically-conductive, rear-electrode segments;
- a third layer located between the first and second  
10      layers and comprising electroluminescent material;
- a fourth layer comprising a plurality of electrically-conductive tracks each of which is electrically connected at a first end to at least one of the rear-electrode segments;
- 15      a fifth layer located between the fourth layer and a sixth layer (defined below), comprising dielectric material and following substantially the path of the electrically-conductive tracks; and
- a sixth layer located between the third and the  
20      fifth layers, comprising an electrically-conductive, backplane which:
- is electrically connected to the front-electrode in front of the backplane such that the potential difference across the third layer in the region of the  
25      sixth layer is substantially zero; and
- follows substantially the path of the electrically-conductive tracks;
- wherein, in use, a driving voltage for driving the illumination of an area of the display is supplied  
30      across the first layer and a rear electrode segment in the second layer.

- 35      2. An addressable electroluminescent display according to claim 1, comprising a plurality of display areas each having the shape of a graphical element and each of which may be separately, selectively illuminated, wherein, at each display area, at least one of the

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first, second or third layers is shaped in the form of the graphical element.

3. An addressable electroluminescent display according  
5 to any of the preceding claims, wherein the first layer  
comprises a plurality of separate  
electrically-conductive, transparent, front-electrode  
segments.
- 10 4. An addressable electroluminescent display according  
to any of the preceding claims, wherein the third layer  
comprises a plurality of electroluminescent material  
segments.
- 15 5. An addressable electroluminescent display according  
to any of the preceding claims, wherein the fifth layer  
comprises a plurality of dielectric tracks each of which  
is associated with one of the electrically-conductive  
tracks and each of which dielectric tracks has  
20 substantially the same two-dimensional form as, but is  
wider than its associated electrically-conductive track  
and, at a first end, stops short of the first end of its  
associated electrically-conductive track.
- 25 6. An addressable electroluminescent display according  
to any of claims 2 to 5, wherein the backplane of the  
sixth layer comprises a plurality of  
electrically-conductive, backplane track-elements.
- 30 7. An addressable electroluminescent display according  
to claim 6, wherein each of the backplane  
track-elements:  
is associated with one of the  
electrically-conductive tracks;  
35 has substantially the same two-dimensional form as,  
but is wider than, its associated  
electrically-conductive track; and

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stops short of the first end of its associated electrically-conductive track.

8. An addressable electroluminescent display according  
5 to claim 7, in dependence upon claim 5 and 6, wherein each of the backplane track-elements stops short of the first end of the associated dielectric track.

9. An addressable electroluminescent display according  
10 to any of claims 6 to 8, wherein backplane track-elements are provided substantially exclusively in areas of the display in which there exists electroluminescent material and a front electrode and an electrically-conductive track.

15 10. An addressable electroluminescent display according to any of claims 6 to 9, wherein backplane track-elements are provided substantially exclusively outside of display areas at which the second layer is shaped in the form of the graphical element.

20 11. An addressable electroluminescent display according to any of the preceding claims, further comprising a dielectric layer located between the second layer and the third layer.

25 12. An addressable electroluminescent display according to claim 11, wherein the dielectric layer substantially follows the path of the electrically-conductive tracks.

30 35 13. An addressable electroluminescent display according to any of the preceding claims, wherein at least one of the second layer, the fourth layer and the sixth layer is formed as a conductive track on a printed circuit board.

14. An addressable electroluminescent display according

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to any of the preceding claims, wherein the second layer, the fourth layer, the fifth layer and the sixth layer are formed as the layers of a multi-layer printed circuit board.

5

15. An item of clothing comprising an addressable electroluminescent display with a plurality of display areas each having the shape of a graphical element and each of which may be separately, selectively illuminated.

10

16. An item of clothing as claimed in claim 15, wherein the addressable electroluminescent display comprises an addressable electroluminescent display as claimed in any 15 of claims 1 to 13.

15

17. An electroluminescent display comprising:  
a first, transparent electrode;  
at least one second electrode;  
20 a layer of electroluminescent material located between the first and second electrodes;  
an electrical conductor in the form of a conductive track, electrically connected to the second electrode and arranged to supply, in use, a driving voltage for  
25 the electroluminescent material to the second electrode;  
an electrically conductive layer which is provided between the electroluminescent material layer and the electrical conductor, substantially following the path of the electrical conductor, said conductive layer being electrically connected to the first electrode, such that the potential difference across the electroluminescent material layer in the region of the electrical conductor is substantially zero; and  
30 a first dielectric layer located between the electrical conductor and the conductive layer.  
35

18. A device as claimed in claim 17, further comprising

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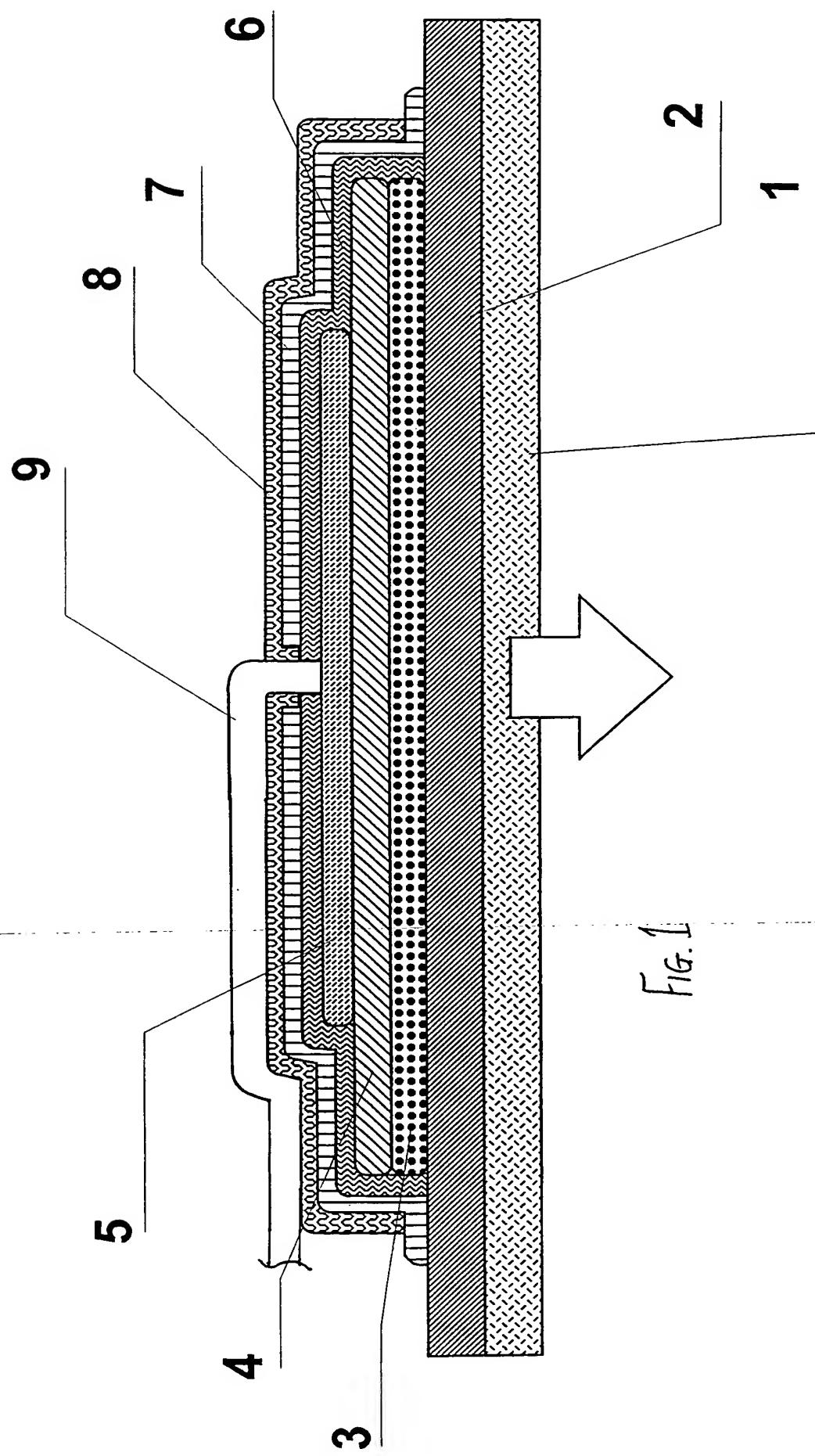
a second dielectric layer located between the second electrode and the conductive layer, wherein the conductive layer and the first and second dielectric layers overlap the area of the second electrode.

5

19. A device as claimed in either of claims 17 or 18, wherein at least one of the second electrode, the conductive layer and the electrical conductor is formed as a conductive track on a printed circuit board.

10

20. An item of clothing comprising an electroluminescent display, wherein the electroluminescent display comprises an electroluminescent device as claimed in any of claims 17  
15 to 19.



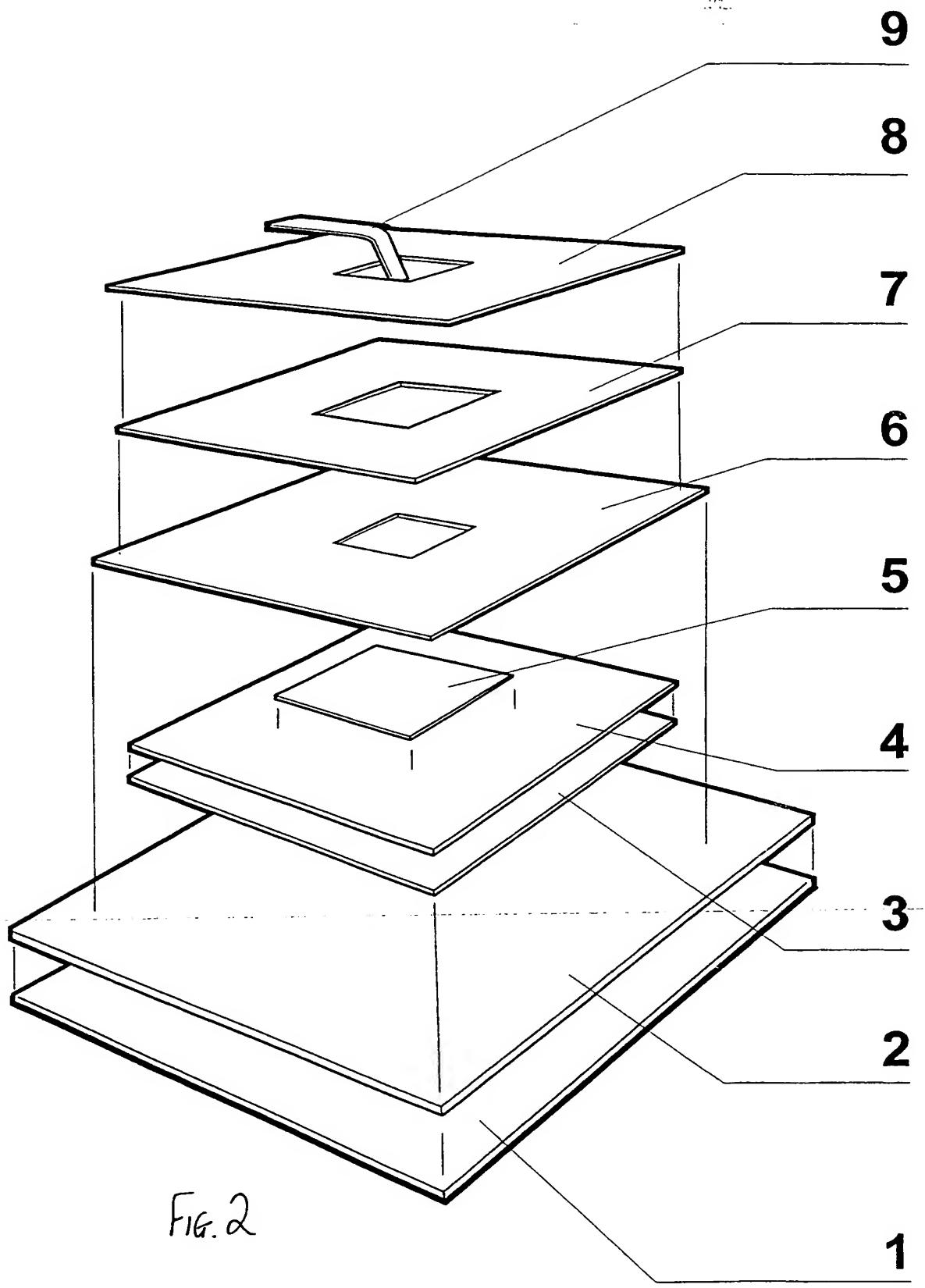


FIG. 2

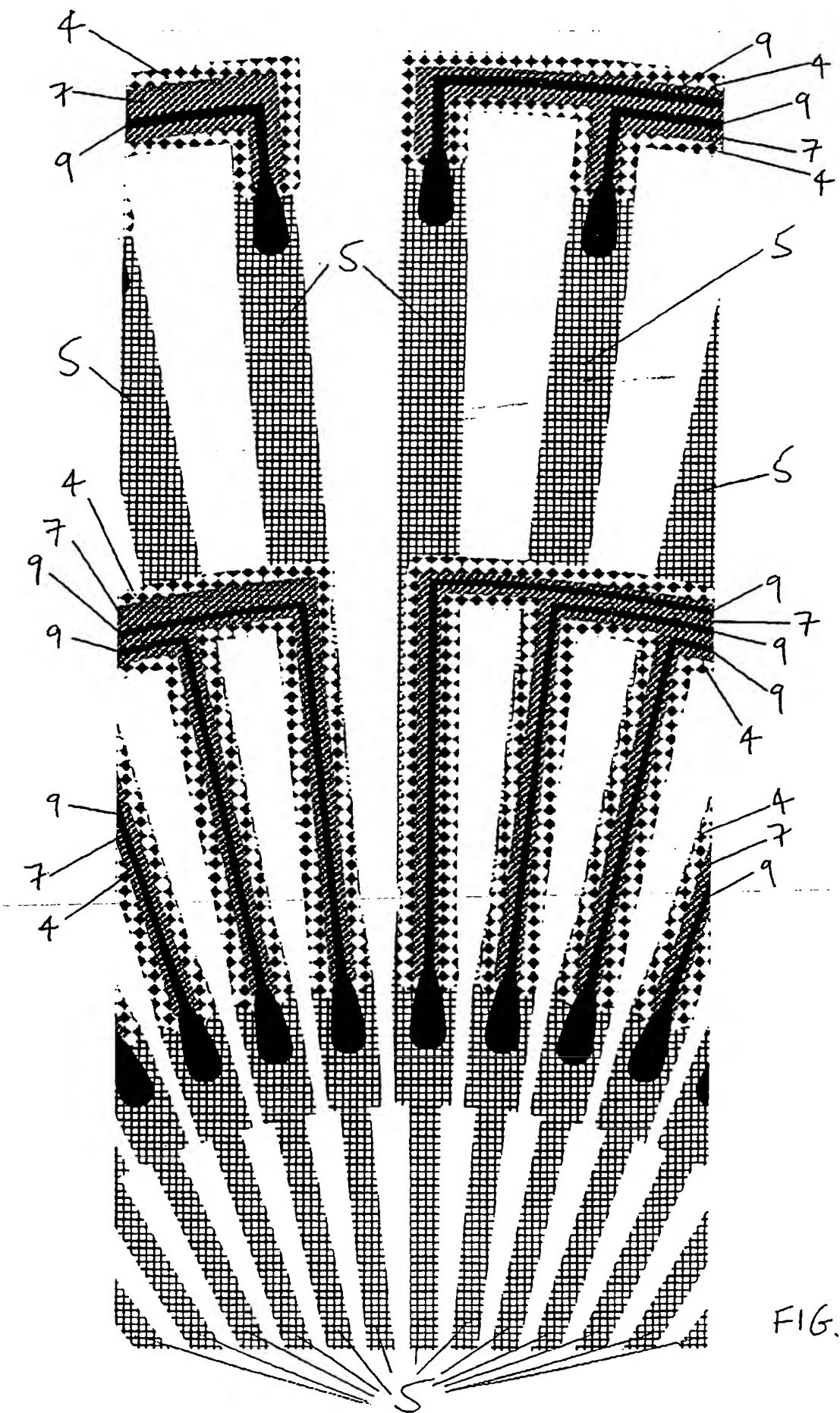


FIG. 3

# INTERNATIONAL SEARCH REPORT

Int'l Application No

PCT/EP 00/04652

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 H05B33/26 H05B33/06

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category <sup>o</sup>	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 757 128 A (TOPP MARK) 26 May 1998 (1998-05-26) the whole document ---	1-14, 17-20
A	US 5 504 390 A (TOPP MARK) 2 April 1996 (1996-04-02) the whole document ---	1-14, 17-20
A	US 5 821 691 A (RICHIE BENJAMIN L ET AL) 13 October 1998 (1998-10-13) the whole document -----	1-14, 17-20

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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- "A" document defining the general state of the art which is not considered to be of particular relevance
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search

Date of mailing of the international search report

5 September 2000

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Name and mailing address of the ISA  
 European Patent Office, P.B. 5818 Patentlaan 2  
 NL - 2280 HV Rijswijk  
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.  
 Fax: (+31-70) 340-3016

Authorized officer

Drouot-Onillon, M-C

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Int'l Application No

PCT/EP 00/04652

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5757128 A	26-05-1998	US 5504390 A	02-04-1996
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US 5821691 A	13-10-1998	NONE	